Pythagoras, Pathways, and Performance:

STEAM and Musical Composition

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Who am I

Monica Sauer

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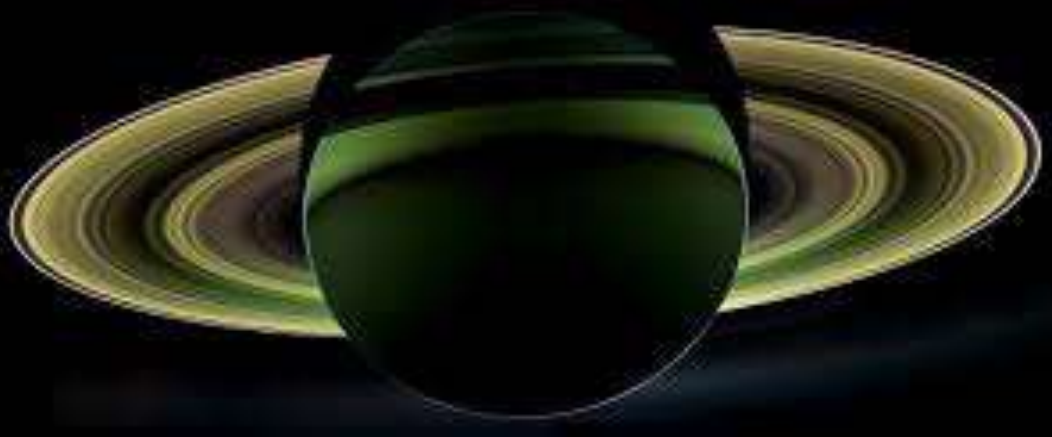
Teaching Artist

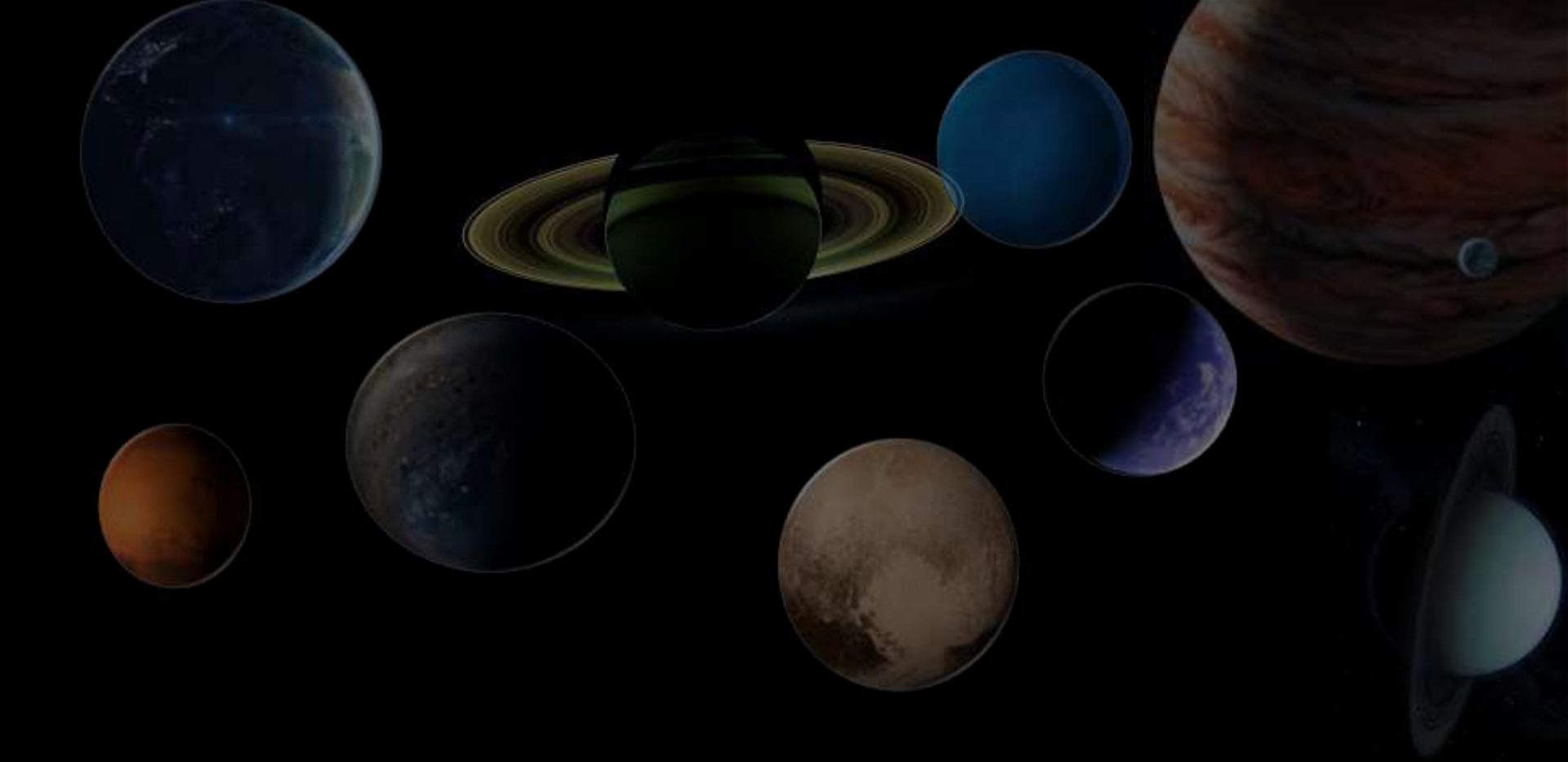
Project Overview

Interdisciplinary Project

ASA's STEM Clubs + Music History

Composition with animation based off the speed of planetary rotation.





Technical Elements

Ancient Philosophers

- Pythagoras
  - Harmony of the Spheres
  - Mathematical relationship between pitches
- Ptolemy
  - Musical relationship to planetary distance
- Plato
  - *The Music of the Spheres*
  - Astronomy & music are connected studies using numerical proportions
- Golden Mean

Physics of Sound

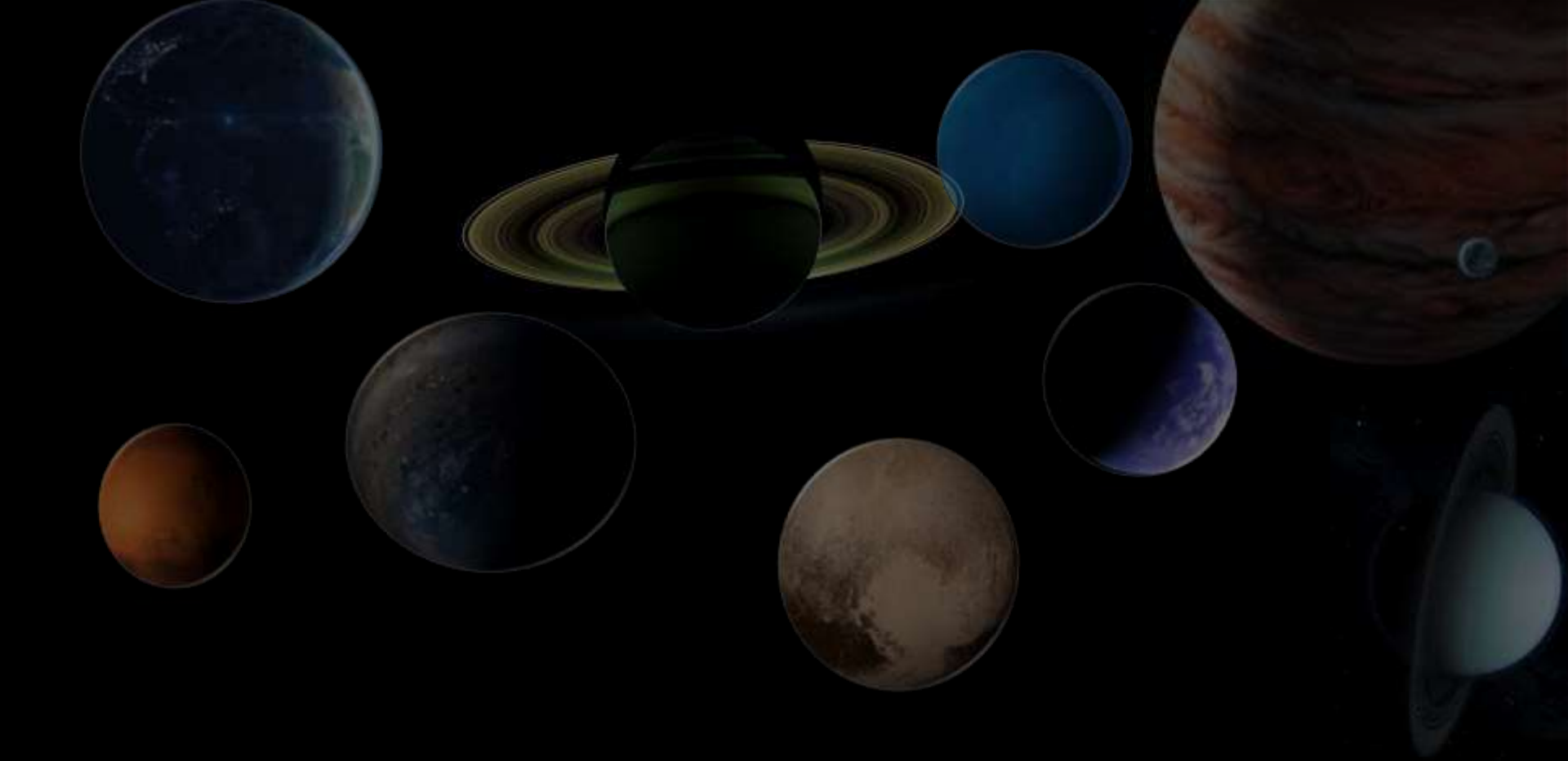
- Pitch Frequency
  - Measuring vibrations per second
  - Slower vibrations = lower pitch
  - Faster vibrations = higher pitch
- Measured in Hertz
  - 1Hz = 1 vibration/second
- Audible Range
  - 20Hz – 20,000Hz

Physics of Light

- Electromagnetic Spectrum
  - Distance of waves of the electrometric field radiating through space
  - Radio waves, microwaves, infrared, visible light, ultraviolet, X-rays, and gamma rays
- Wavelength measured in Ångströms
  - $1Å = 10^{-10}\,m$
- Visible range
  - 3800Å (violet) - 7800Å (red)

Doctrine of Affections

- Music is composed to evoke specific emotions
  - Admiration
  - Love
  - Hatred
  - Desire
  - Joy
  - Sorrow
- Compositional Techniques
  - Tonal Center
  - Musical Motives



Collaborators

Middle School Robotics

- Engineering Club
  - Team Building
  - Presentation Skills
  - National Robotic Competitions
- INTO ORBIT^{SM} Global Challenge
  - First Lego League
  - Human emotional and physical impact after being in orbit
    - Higher levels of radiation
    - Emotional fatigue, depression, and loneliness

Mu Alpha Theta

- Math Honors Society
  - Peer Tutoring
  - Creative Applications
  - Math Puzzles
- Translating orbital rate into musical notes and colors

Girls Who Code

- Inspiring young girls to join the computer science industry
  - Study the impact of prominent women
  - Learn basic coding applications
- Design the visuals using the colors from the notes of the composition
  - Khan Academy
  - JavaScript

Music History & Culture

- Music's relationship with structure and form
  - Learn composition from all musical time periods
  - Compose with melodicas
- Principal group in the collaboration
  - Use assigned notes linked to planets
  - Assign an affect
  - Compose in NoteFlight

What do you Hear

Planet	Affect Description	Musical Characteristics
Mercury		
Venus		
Uranus		

Planet	Orbital Period (in days)	Frequency in Hz	Pitch Center	Approx. Wave Length in Å	Color	Affect Description	Pitch Selections
Mercury	87.96	289.27	C#	4917	Green	Flighty	Ionian
Venus	224.70	452.94	A	6619	Orange	Amor	Mixolydian
Earth	365.242	278.65	C#	4975	Green-Turquoise	Congealment	Chromatic
Mars	686.09	296.69	D	4641	Blue	Maleficent	Aeolian
Jupiter	4332.59	375.85	F#	7977	Deep Red	Powerful	Lydian
Saturn	10,759.21	302.70	D#/D	4452	Deep Blue	Wise	Dorian
Uranus	30689.6	424.49	G#	7063	Red	Mischievous	Locrean
Neptune	60,183.6	432.92	A	6925	Orange	Baron	Whole Tone
Pluto	90,740.5	287.14	D	4720	Light Blue	Complex & Misunderstood	Blues

Pitch	Hz	Color	Pitch	Hz	Color
C	261.63	Green	F#	369.99	Deep Red
C#	277.18	Green-Turquoise	G	392.00	Red
D	293.66	Blue	G#	415.30	Red-Orange
D#	311.13	Blue-Indigo	A	440	Orange
E	329.63	Violet	A#	466.16	Yellow
F	349.23	Very Dark Red	B	493.88	Lemon

Composition Details

- Form
  - AABA (8+8+8+8+2)
    - Each A section is slightly different
  - Golden Mean
    - 8, 13, 21, 34
  - Timbre or marked change at 8 & 13
  - Climax at 21
  - 34 Measures Total

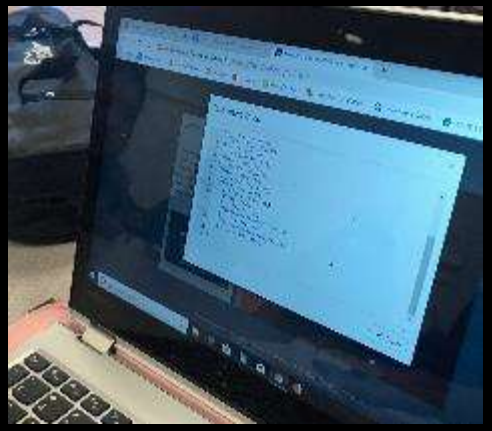
- Technical Elements
  - Title
  - Use planet descriptions for inspiration
  - Use assigned pitch selections
  - 4 motives as source material
  - 4 parts for your own instruments
  - Texture – student choice
  - 4/4 time
  - Q=60

Students in Action

Middle School Robotics

Mu Alpha Theta

Girls Who Code



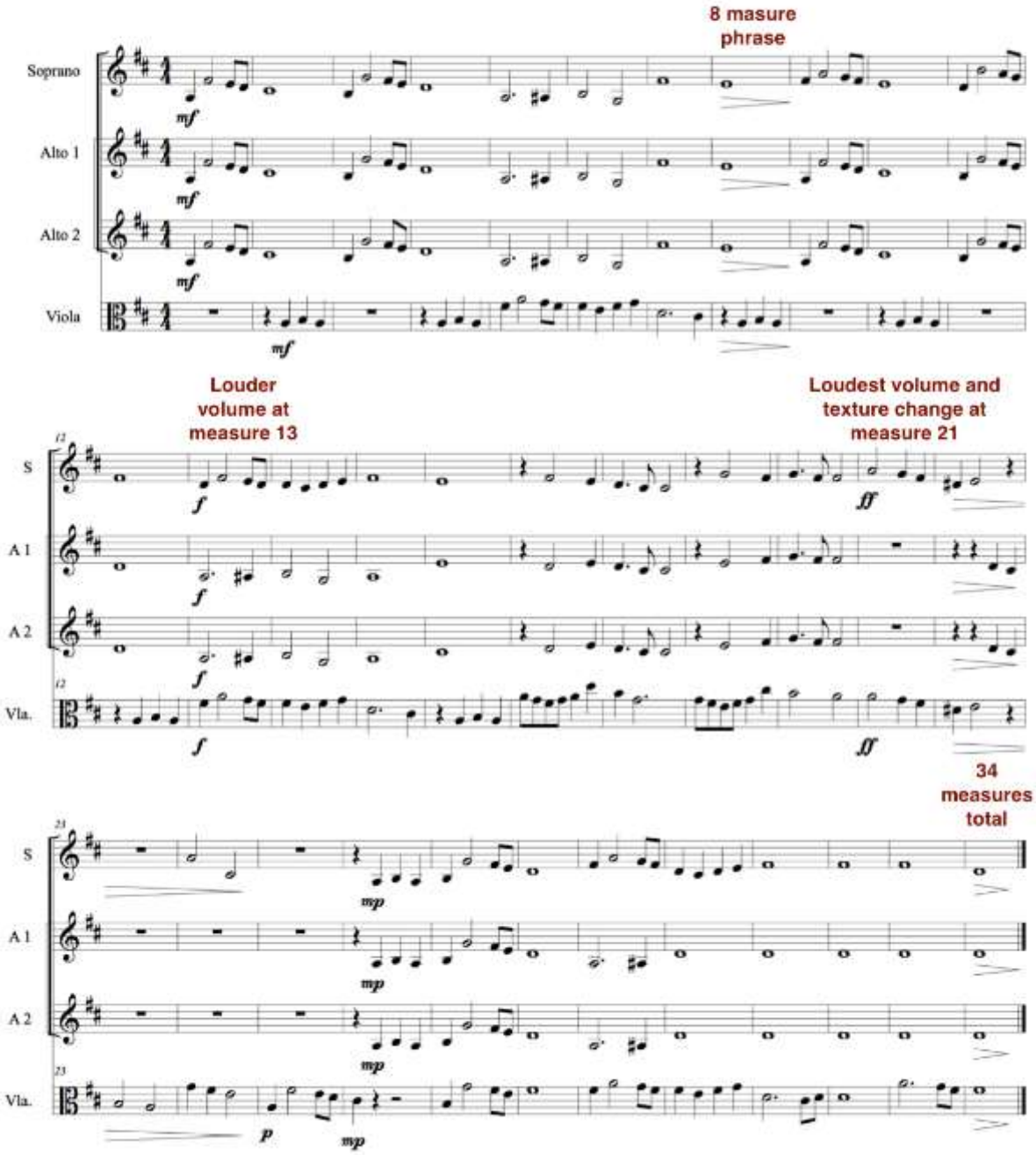
Music History & Culture

Score

Venus

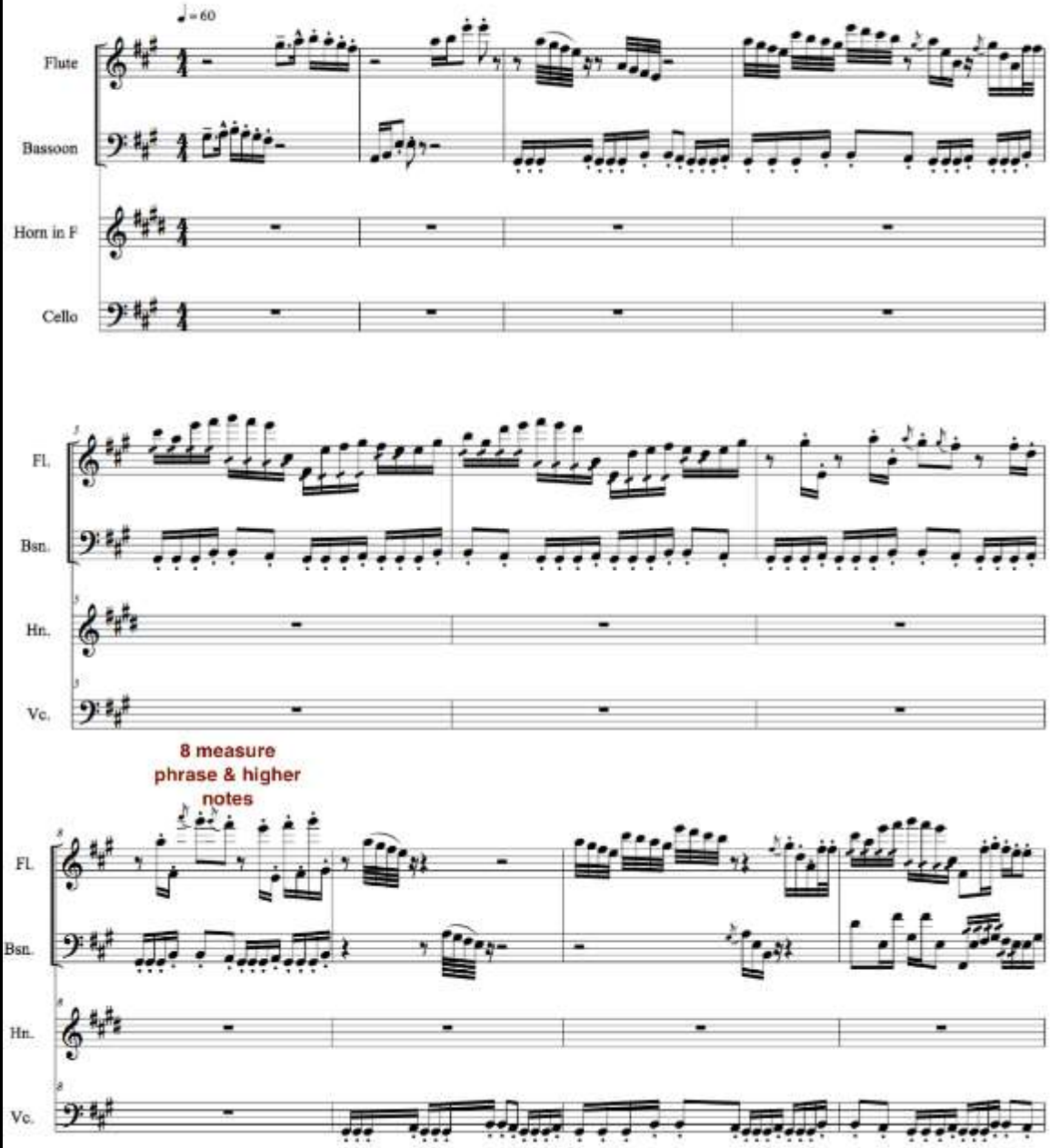
A Mixolydian

The Aphrodites

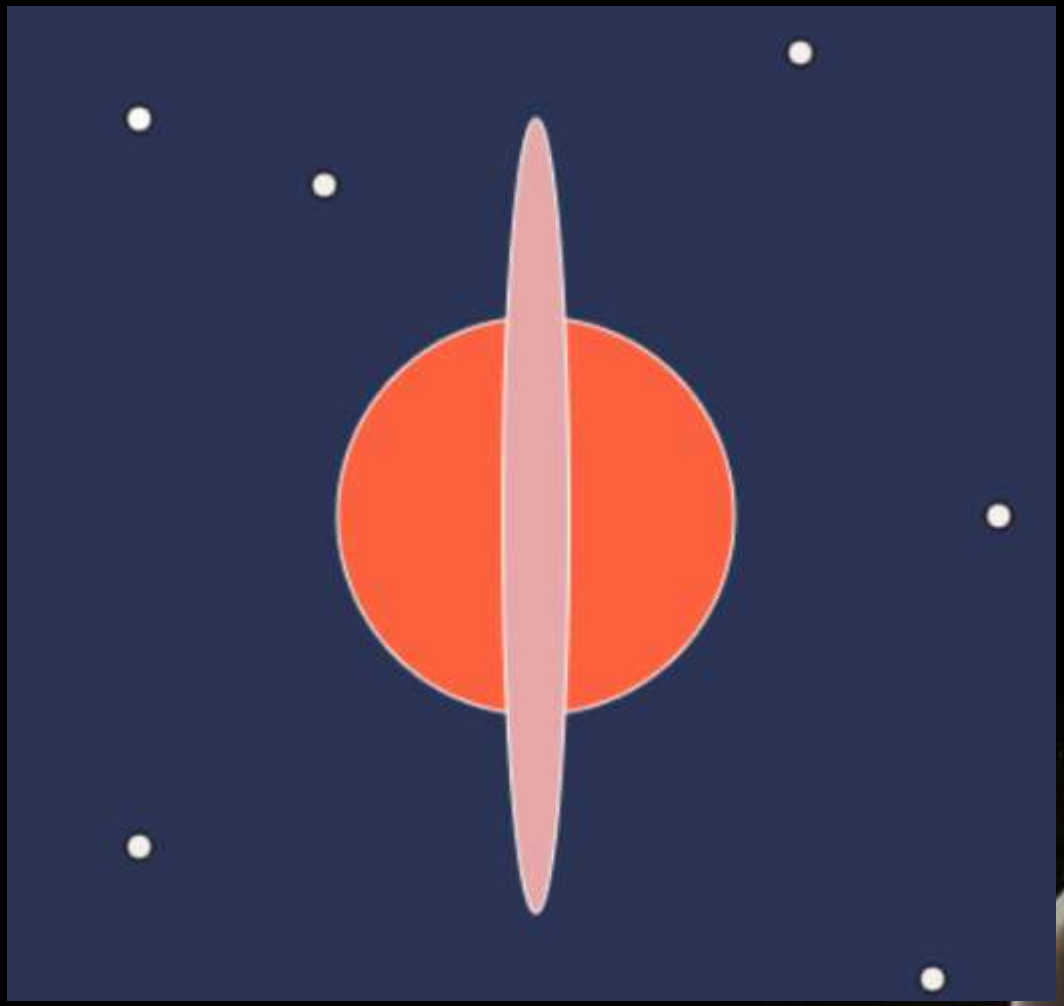


Score

Uranus



Animation Sample



Create Your Own STEAM Project

- Goals
  - Creative Student Product
  - Interdisciplinary with more than 1 STEAM organization
  - Stimulate innovative partnerships

- Use your classroom as the principal collaborator
- Team up to make and arts and academic pairing or group
- Find a common topic you wish to explore